PCT
WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : **B01D 35/06, 46/42, 46/24** A1

(11) International Publication Number: **WO 97/03744**

(43) International Publication Date: 6 February 1997 (06.02.97)

(21) International Application Number: PCT/US96/09729

(22) International Filing Date: 10 June 1996 (10.06.96)

(30) Priority Data:
60/002,432 18 July 1995 (18.07.95) US

(71) Applicant *(for all designated States except US)*: PARKER-HANNIFIN CORPORATION [US/US]; 17325 Euclid Avenue, Cleveland, OH 44112 (US).

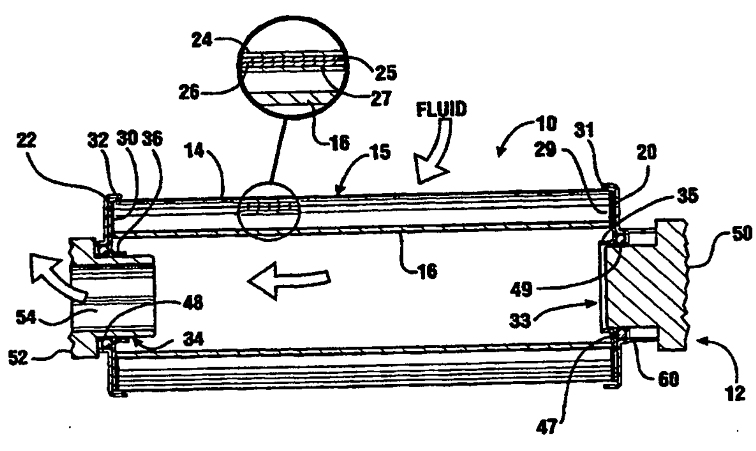
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: GEMBOLIS, Donald, J. [–/US]; 2530 Gradwohl, Toledo, OH 43617 (US). SHANE, Bruce, E. [–/US]; 13203 County Road #6, Delta, OH 43515 (US).

(74) Agent: HUNTER, Christopher, H.; Parker-Hannifin Corporation, 17325 Euclid Avenue, Cleveland, OH 44112 (US).

(81) Designated States: US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: CONDUCTIVE FILTER ELEMENT



(57) Abstract

A filter apparatus (10) which dissipates static charge from fluid flowing through the apparatus has a filter housing (12) enclosing a filter element (14). The filter element includes a tubular filter media assembly (15) which incorporates a conductive structure to draw off static charge in fluid passing through the media. The tubular filter media assembly comprises an outer steel mesh support layer (24); a first intermediate layer (25) of a filtration media; a second intermediate layer (26) of a carbon material, e.g., stainless steel, nickel or carbon fiber mesh, mat or matrix; and an inner steel mesh support layer (27). The filter media assembly is pleated and disposed around a central perforated conductive tube (16). The filter media is electrically connected at one or both ends through conductive adhesive or epoxy to at least one conductive end cap (20, 22). The conductive end cap has a central opening (33, 34), and receives a portion of the grounded filter housing (50, 52), for example, an inlet tube. A conductive elastomeric O-ring seal (48, 49) is disposed between the conductive end cap and the respective portion of the filter housing extending through the end cap opening. The O-ring seal electrically connects (grounds) the conductive end cap(s) to the respective housing portion to provide a flexible ground path for carrying away static charge in the fluid passing thorough the cartridge.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgystan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

Title of Invention CONDUCTIVE FILTER ELEMENT

FIELD OF THE INVENTION

The present invention relates generally to fluid filters, and more particularly to a filter which removes static electric charge from fluid passing through the filter.

BACKGROUND OF THE INVENTION

Filter apparatus are known for filtering particles in a fluid stream. The filtration operation essentially removes particles of a particular size from the fluid stream to cleanse the fluid stream of contaminants.

As the fluid flows through the filter apparatus, certain fluids such as hydraulic fluids and diesel and gasoline fuels can have resistance to the conductance of electricity. As such, a static charge can build up within the fluid from the action of the fluid flowing through the non-metallic piping and filter media. With some of the more advanced compositions of filter media, and with the increasing acceptance of synthetic and biodegradable fluids with low conductivity values (i.e., little or no metal additives), static charge can accumulate within the filter apparatus. When the potential between the fluid and a conductive housing component reaches a certain level, a spark can jump to a surface of the housing component. This can be undesirable in many situations.

One technique for removing the static charge in the fluid is to add an anti-static agent such as DuPont Stadis 450 to make the fluid slightly conductive. However, anti-static agents can lose potency over time and will typically have to be re-added (re-doped) to the fluid at regular intervals.

Certain filter apparatus are also known which attempt to remove static charge as fluid flows through the filter apparatus. For example, Colvin, et al., U.S. Patent No. 3,933,643, discloses a technique to remove static charge in filters for a flammable liquid or gas wherein nonconductive fibrous filter elements are treated with resins containing finely divided carbon. The treated fibers

are then fabricated into filter elements which are electrically connected to metal end caps using a conductive sealing composition. The metal end caps are then electrically connected to ground. The static charge in the liquid or gas passing through the filter element is drawn off through the ground path.

Dornauf, U.S. Patent No. 3,186,551, shows a similar technique wherein a pair of conductive inner and outer perforated metal tubes surround the filter media, while a conductive wire helix is included within the filter media. The wire helix and metal tubes are electrically connected to metal disk members at either end of the filter element and then to metal annular members. One metal annular member is in direct mechanical contact with a central spindle which contacts a metal partitioning wall of the filter housing, while the other annular member is in direct mechanical contact with the metal partitioning wall.

Koch, et al., U.S. Patent No. 4,999,108, shows a similar technique where a wire electrically connects a perforated metal support tube intermediate the filter media with a metal fastening screw. The metal fastening screw is then grounded by direct mechanical contact with a metal fastening spider (housing).

Still another technique for grounding components within a filter apparatus is shown in Harms, U.S. Patent No. 4,187,179, wherein spring fingers are in direct mechanical contact with and electrically connect a metal support plate to a lid of the filter container.

While the above types of filter apparatus might be useful in certain situations, the applicants believe that the known filter apparatus can require special housing structures for the filter elements or additional parts such as spring fingers or spindles; require tight tolerances and/or intimate mechanical contact between the filter element and the housing; and can be difficult and time-consuming to assemble such that a proper ground path is provided and maintained between the filter element and the housing. Applicants believe that heretofore there has not been a filter apparatus which removes static charge from fluid and which (i) does not require any special housing structure other than what would normally be found with nonconductive filter apparatus,

and (ii) is easy to assemble so as to provide and maintain a proper ground path between the filter element and the housing.

As such, applicants believe there is a demand for a new and improved filter element which addresses the above drawbacks.

SUMMARY OF THE INVENTION

The present invention provides a filter apparatus which dissipates static charge from fluid flowing through the apparatus and which has a filter element which can be easily assembled within a filter housing without any additional structure beyond that which would typically be found with nonconductive filter elements. As an additional benefit, the filter element can be used in filter housings where static charge build-up is not an issue.

According to the principles of the present invention, the filter apparatus includes a filter housing supporting and enclosing a filter cartridge or element. The filter cartridge comprises a tubular filter media assembly which incorporates a conductive structure to draw off static charge in fluid passing through the media. The tubular filter media assembly preferably comprises an outer support layer formed from, e.g., epoxy coated steel mesh; a first intermediate layer comprising a fiberglass filtration layer; a second intermediate layer comprising, e.g., stainless steel, nickel or carbon fiber mesh, mat or matrix; and a inner support layer comprising, e.g., epoxy-coated steel mesh. The filter media assembly can be pleated and disposed around a central perforated conductive tube.

The filter media assembly is electrically connected through conductive adhesive or epoxy to at least one of the end caps for the filter assembly. One (or both) of the end caps has a central opening and is formed from conductive material. The opening in the end cap is designed to receive a portion of the grounded filter housing, for example an inlet tube. Conductive resilient material is disposed between the end cap and the portion of the filter housing extending through the opening. Preferably, the conductive resilient material comprises an elastomeric O-ring seal.

The O-ring seal is in electrical contact the each end cap and with the filter housing portion. The O-ring seal can be located within a channel or groove surrounding the opening in an end cap to electrically connect (ground) the end cap to the housing portion.

The conductive elastomeric O-ring seal provides flexibility in allowing the filter element to be easily assembled with the filter housing and to create a proper ground path between an end cap and the filter housing without direct mechanical contact between the element and the housing. The conductive elastomeric O-ring seal thereby allows the tolerances in the opening in the end cap, and in the portion of the housing extending into the end cap, to vary to a greater extent while still maintaining the ground path. In addition, the conductive elastomeric seal does not require any additional assembly steps or modification of the filter housing, and can be used even when static charge build-up in the filter is not an issue.

According to an additional aspect of the present invention, a metal contact spring can be disposed around the portion of the housing extending into an end cap. The spring extends between the end cap and the housing and provides an additional or alternate ground path between the end cap and the filter housing.

Other features and advantages of the present invention should become further apparent from the following description and attached claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the layered construction of the filter media assembly of the present invention;

Figure 2 is a cross-sectional end view of the pleated filter assembly of the present invention;

Figure 3 is a lengthwise sectional view of a filter apparatus; and

Figure 4 is an enlarged sectional view of the conductive O-ring seal and associated assembly at one end of the filter apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a filter apparatus constructed according to the principles of the present invention is indicated generally at 10. The apparatus includes a filter housing, indicated generally at 12, and a filter cartridge or element 14. The filter housing 12 is of conventional design and supports the filter cartridge 14 along at least one end within the fluid system. The filter housing is grounded within the fluid system in a conventional manner.

The filter cartridge 14 comprises a filter media assembly, indicated generally at 15, disposed around a central perforated metal tube 16, and a pair of metal end caps 20, 22 disposed at opposite ends of the filter cartridge. Referring in particular to Figure 1, the filter media assembly 15 preferably comprises a multi-layered structure having means for filtering fluid, and in particular hydraulic fluid, and for drawing off static charge in the fluid flowing through the filter cartridge. Preferably, this means includes an outer or upstream layer 24 of a support material. The upstream layer comprises an epoxy-coated steel mesh with a porosity chosen so as to allow substantially unimpeded fluid flow through the mesh while providing support for the underlying layers. Preferably, this layer has an 18 x 14 mesh count (18 wires per inch in the longitudinal direction and 14 wires per inch in the lateral direction).

This means also includes a first intermediate filtration layer 25 provided in surface-to-surface contact with the outer layer 24 on the downstream side of the outer layer 24. Filtration layer 25 preferably comprises a conventional high-efficiency microfiber media, such as fiberglass. Preferably, the filtration layer has an efficiency of two microns absolute.

The means further includes a second intermediate layer 26 provided in surface-to-surface contact with the filtration layer 25 on the downstream side of the filtration layer 25. The second intermediate layer is preferably a conductive layer formed from, e.g., a stainless steel, nickel or carbon fiber mesh, mat, or matrix, and is in thin sheet form. The porosity (efficiency) of the conductive layer 26 is preferably great enough to allow fluid to flow substantially unimpeded through the conductive layer, but is small enough to carry the charge away from fluid passing

through the mesh. Preferably, the conductive layer has an efficiency of 40 microns absolute, and as such, is at least an order of magnitude greater than the efficiency of the filtration layer 25. The efficiency of this layer can, of course, vary depending upon the particular static charge requirements.

Finally, the means also includes an inner or downstream support layer 27 provided in surface-to-surface contact with the conductive layer 26 on the downstream side of the conductive layer 26. The downstream support layer 26 preferably includes an epoxy-coated steel mesh having the same porosity as the outer layer 24, and which provides strength and integrity for the upstream layers. The various layers of the filter media assembly described above are preferably each of the same width and length such that the entire assembly is provided in a neat stack and can be easily manufactured, although as should be apparent, the thickness of the various layers can vary depending upon the particular application. In any case, it is important that the conductive layer 26 is accessible from at least one end of the filter media assembly.

Furthermore, while one filter media assembly is described above, it should be apparent to those skilled in the art that the structure of the filter media assembly can vary depending upon the filtration requirements and static charge built-up in the system. In fact, in its simplest sense, the present invention only requires a filter media assembly which includes (i) filtration media chosen so as to provide appropriate filtration efficiency, and (ii) a conductive structure associated with the filtration media which removes charge from fluid passing through the filtration media, and which has an electrical contact point which is accessible through the filtration media, for example along an end of the filtration media.

The filter media assembly 15 is then disposed around the central perforated tube 16, as illustrated in Figure 2. The central tube typically has rather large openings 28 (perforations) to allow the fluid to pass through the tube substantially unimpeded. Preferably, the filter media assembly 15 is initially pleated using conventional pleating equipment, and is then disposed around the center tube with the pleats extending longitudinally along the tube and projecting radially

outward from the tube. The circumferential ends of the pleated filter media assembly could be attached together in a conventional manner, such as by an adhesive. Of course, the filter media assembly 15 could also be unpleated and wrapped helically or spirally around the center tube, if desired.

Referring now to Figure 3, the metal end caps 20 and 22 are located at opposite ends of the filter media assembly 15. Preferably, the end caps 20, 22 are each attached to the filter media assembly with a mass of conductive epoxy or adhesive, as indicated at 29, 30, respectively (Figure 1). The conductive epoxy or adhesive electrically connects the end caps to the filter media assembly, and in particular, electrically connects the end caps to the conductive layer 27. The conductive epoxy or adhesive also electrically connects the center metal tube 16 to the end caps. Each end cap 20, 22 preferably has a cup-shaped design with a peripheral annular flange 31, 32, respectively, which extends a short distance axially along the outer surface of the outer support material 24. Each end cap 20, 22 preferably has a central opening, indicated generally at 33, 34, respectively, defined by an inwardly-turned annular flange 35, 36, respectively, however, one end cap could also be formed without an opening, as will be described herein in more detail.

Preferably each end cap comprises a multi-piece structure. For example, as illustrated in Figure 4, end cap 22 preferably comprises an inner cap member 40 which includes, as an integral piece, flat base 41, and the inner annular flange 36. End cap 22 also includes an outer cap member 43 which includes, as an integral piece, a flat base 44, the outer annular flange 32, and an "L" shaped annular flange 45 which forms an annular (C-shaped) channel or groove, indicated generally at 46, with the inner cap member 40. End cap 20 (Figure 3) has substantially the same structure as end cap 22, and also forms an annular C-shaped channel or groove, indicated generally at 47.

A conductive resilient material is disposed within the channel in each end cap. For example, a conductive resilient material 48 is disposed in channel 46 in end cap 22, and a conductive resilient material 49 is disposed in channel 47 in end cap 20. The conductive resilient

materials 48, 49 are each preferably conductive elastomeric O-ring seals. Each seal 48, 49 has a dimension which is slightly larger than the dimension of the respective channel in which it is located, such that each seal is retained in and slightly protrudes from the channel.

The seals 48, 49 can be comprised of an elastomer such as a silicone or fluorosilicone polymer infused with a high density conductive filler to create an electric path. Conductive fillers can comprise graphite, copper, or other metallic fillers, as should be known to those skilled in the art. One conductive elastomer appropriate for the present invention is available from the Parker Seal Division of the assignee of the present invention under the mark PARSHIELD CONDUCTIVE ELASTOMER. Of course, other conductive elastomers can be used with the present invention.

In any case, the filter media assembly 15, center tube 16, end caps 20 and 22, and conductive elastomer seals 48, 49 are initially assembled together as the filter cartridge. The structure of the filter cartridge is such that fluid is directed radially inward through the outer layer, passes through the first intermediate layer, passes through the second intermediate layer, and then passes through the inner layer, in succession. It should also be apparent to those skilled in the art that the flow could also be reversed, i.e., pass radially outward through the filter media assembly. In this instance, it is preferred that the location of the conductive layer 26 and filtration layer 25 be reversed, i.e., that the conductive layer 26 be disposed on the outer downstream side of the filtration layer 25. In other words, it is preferred that the conductive layer 26 be on the downstream side of the filtration layer 25.

The cartridge is then disposed within the filter apparatus, such as by locating the cartridge over opposite portions of a grounded filter housing, such as indicated at 50, 52 in Figure 3. One of the filter housing portions, for example portion 52, can be an inlet pipe to the fluid system and can thereby have a central inlet bore 54, while the other filter housing portion 50 can comprise a solid cylinder. Preferably both filter housing portions 50, 52 are grounded, although it is only necessary to have one grounded. In any case, the filter housing portions 50, 52 are received within

the central openings 35, 36 formed in the end caps of the filter cartridge. The filter cartridge receives the portions of the filter housing with the conductive elastomeric seals 48, 49 sealing against the periphery of the filter housing portions. As should be apparent, the cartridge is uniquely suited to be used as a replaceable element, however, the cartridge can also be used as a non-replaceable element.

The conductive seals provide a ground path between the filter cartridge and the housing portions, as well as provide a fluid tight seal against the filter housing. Any static charge build-up in the filter media assembly 15 is conducted from the filtration layer 25 to the conductive layer 26 because of their adjacent proximity to each other, passes through the conductive epoxy 29, 30 to the conductive end caps 20, 22, and then passes through the conductive elastomeric seals 48, 49 to the grounded filter housing portions, thus dissipating any charge received from the fluid passing through the apparatus. The downstream location of the conductive layer 26 has been determined to satisfactorily carry away charge from the upstream adjacent filtration layer 25.

While the present invention has been described above with respect to a pair of end caps, each of which has a central opening to receive a filter housing portion such that a ground path is provided through both ends of the filter cartridge, it should be apparent to those skilled in the art that the charge in the fluid could be dissipated using a single ground path through only one end cap of the filter assembly. In this case, only one end cap can include a central opening to receive a housing portion. The other end cap can be a solid disk and not receive a housing portion, or can receive a housing portion but have a non-conductive seal or be formed from non-conductive material.

Additionally or alternatively, although not preferred, a conductive metal spring, indicated generally at 60, can also be provided around one (or both) housing portions 50, 52. Spring 60 provides another flexible ground path from filter media assembly 15 to the housing 12 by contact with the conductive end caps. Spring 60 also provides a bias on the filter element to prevent the filter element from vibrating or moving axially back-and-forth on the housing portions.

The filter apparatus with conductive elastomeric seal(s) described above provides a filter element which can be easily assembled with the housing portions to create a ground path without requiring direct mechanical contact with the filter housing. The conductive seals provide the ground path to the housing portions regardless of the relative axial positioning between the filter element and the housing portions. That is, there is flexibility in locating the filter cartridge on the housing portions without worrying about direct, intimate contact with the end caps of the filter cartridge because of the resiliency of the seals. As such, the tolerances between the filter element and the housing can vary to a greater degree while still maintaining the proper ground path. Moreover, because the conductive seals are carried on the filter element, the present invention does not require any modification of the filter housing or additional assembly steps. Even if the fluid flowing through the filter apparatus does not have static charge, the filter element of the present invention provides filtering of the fluid to maintain the fluid at an appropriate cleanliness.

CLAIMS

WHAT IS CLAIMED IS:

1. A filter cartridge for filtering particulates from a fluid in a fluid system, said filter cartridge comprising:

a filtration media assembly having i) a first layer of filtration media in tubular form, said first layer of filtration media having a predetermined particle filtration efficiency, and ii) a second layer of a conductive media in tubular form arranged adjacent to and concentric with said first layer, said second layer of conductive media having a particle filtration efficiency which is less than said first layer,

an end cap supporting said filtration media assembly and in electrically conductive relationship with said second layer of conductive media, and

a resilient sealing member carried by said end cap for sealing against a housing portion in the fluid system, said resilient sealing member being formed of a material which provides a ground path from said inner layer to the housing portion, wherein fluid directed through said cartridge passes initially through the first layer and then through the second layer and any static charge in the fluid is dissipated through the ground path.

2. The cartridge as in claim 1, wherein said resilient sealing member comprises a conductive elastomeric O-ring seal.

3. The cartridge as in claim 1, further including a second resilient sealing member carried by a second end cap for sealing against another housing portion of the fluid system, said second resilient sealing member being formed of a material which provides a second ground path from said inner layer to the housing portion.

4. The cartridge as in claim 3, wherein said first and second resilient sealing members each comprise conductive elastomeric O-ring seals.

5. The cartridge as in claim 4, wherein said first filtration media layer is adjacent to and in surface-to-surface contact with said second conductive media layer.

6. The cartridge as in claim 5, wherein said first filtration layer is disposed radially outward in the from the second conductive layer.

7. The cartridge as in claim 6, further including a second support layer disposed radially inward from the conductive support layer, a third support layer disposed radially outward from the filtration media, and a conductive perforated tube located centrally within the first filtration layer, second support layer, third support layer and second conductive layer.

8. The cartridge as in claim 7, wherein said first filtration layer, second and third support layers, and second conductive layer are pleated together and disposed around a central perforated tube.

9. The cartridge as in claim 1, wherein said end cap is located on an end of the first and second layers, said end cap providing a ground path from the second layer to the resilient sealing member.

10. The cartridge as in claim 9, wherein said first end cap is formed from conductive material.

11. The cartridge as in claim 10, further including a conductive adhesive mass disposed between the second conductive layer and said first end cap which provides a ground path between the second layer and said first end cap.

12. The cartridge as in claim 1, wherein said inner layer is a thin sheet of a conductive material in mesh, mat or matrix form.

13. The cartridge as in claim 1, wherein said outer layer is a fiberglass media.

14. A filter assembly for filtering particulates from a fluid, said filter assembly comprising:

a housing for receiving a removable filter cartridge, and

a filter cartridge disposed in the housing, said filter cartridge including a filter media assembly having i) an outer layer of filtration media in tubular form, said outer layer of filtration media having a predetermined particle filtration efficiency, and ii) an inner layer of a conductive media in tubular form arranged adjacent to and concentric with said outer layer, said inner layer of conductive media having a particle filtration efficiency which is less than said outer layer,

a pair of end caps supporting said filtration media assembly, at least one of said end caps being in electrically conductive relationship with said inner layer of conductive media, and

a resilient sealing member carried by said at least one end cap for sealing against a housing portion in the fluid system, said resilient sealing member being formed of a material which provides a ground path from said inner layer to the housing portion, the fluid being directed through said cartridge such that the fluid passes through the outer layer and then through the inner layer and any static charge in the fluid is dissipated through the ground path.

15. The filter assembly as in claim 14, wherein said housing includes a tubular housing portion which is received within an opening formed in one end cap, said resilient sealing member being disposed between and electrically grounding said tubular housing portion and said one end cap.

16. The filter assembly as in claim 15, further including a second resilient sealing member carried by another end cap for sealing against another housing portion of the fluid system, said second resilient sealing member being formed of a material which provides a second ground path from said inner layer to the housing portion, and a second tubular housing portion which is received within an opening formed in said other end cap, said second resilient sealing member being disposed between and electrically grounding said second tubular housing portion and said other end cap.

17. The filter assembly as in claim 15, further including a conductive spring received around said tubular housing portion and extending between said housing portion and said other end cap.

18. A fluid system, comprising:

a fluid path, said fluid path having fluid flowing through said path with static charge,

a housing supporting a removable filter cartridge, and

a filter cartridge disposed in the housing, said filter cartridge including

i) a filtration media assembly having a) a first layer of filtration media in tubular form, said first layer of filtration media having a predetermined particle filtration efficiency, and b) a second layer of a conductive media in tubular form concentric with said first layer, said second layer of conductive media having a particle filtration efficiency which is less than said first layer,

ii) a pair of conductive end caps supporting said filtration media assembly, at least one of said end caps being in electrically conductive relationship with said second layer of conductive media, and

iii) a resilient sealing member carried by said at least one of said end cap for sealing against a housing portion in the fluid system, said resilient sealing member being formed of a material which provides a ground path from said inner layer to the housing portion, the fluid being

directed through said housing such that the fluid passes through the outer layer and then through the inner layer and any static charge in the fluid is dissipated through the ground path.

19. A filter cartridge for filtering particulates from a fluid in a fluid system, said filter cartridge comprising:

i) filter means for providing a predetermined particle filtration efficiency of the fluid through the fluid system and for drawing off static charge in the fluid,

ii) a conductive end cap supporting an end of the filter means,

iii) a conductive elastomeric O-ring seal for sealing against a grounded housing portion in the fluid system, the conductive elastomeric O-ring seal being retained and supported by the end cap such that the conductive elastomeric O-ring seal is in electrical contact with the end cap, said conductive O-ring seal being formed of a material which provides a ground path from said filter means to the housing portion such that static charge in fluid passing through the cartridge is dissipated through the ground path.

20. A method for filtering particulates from a fluid in a fluid system, comprising:

providing a fluid path, said fluid path having fluid flowing through said path with static charge,

providing a housing supporting a removable filter cartridge, and

providing a filter cartridge disposed in the housing, said filter cartridge including i) a filtration media assembly having a) a first layer of filtration media in tubular form, said first layer of filtration media having a predetermined particle filtration efficiency, and b) a second layer of a conductive media in tubular form concentric with said first layer, said second layer of conductive media having a particle filtration efficiency which is less than said first layer, ii) a pair of conductive end caps supporting said filtration media assembly and in electrically conductive relationship with said second layer of conductive media, and iii) a resilient sealing member carried

by one of said end caps for sealing against a housing portion in the fluid system, said resilient sealing member being formed of a material which provides a ground path from said inner layer to the housing portion, and

directing the fluid through said housing such that the fluid passes through the outer layer and then through the inner layer and removing any static charge in the fluid through the ground path.

Sheet 1/3

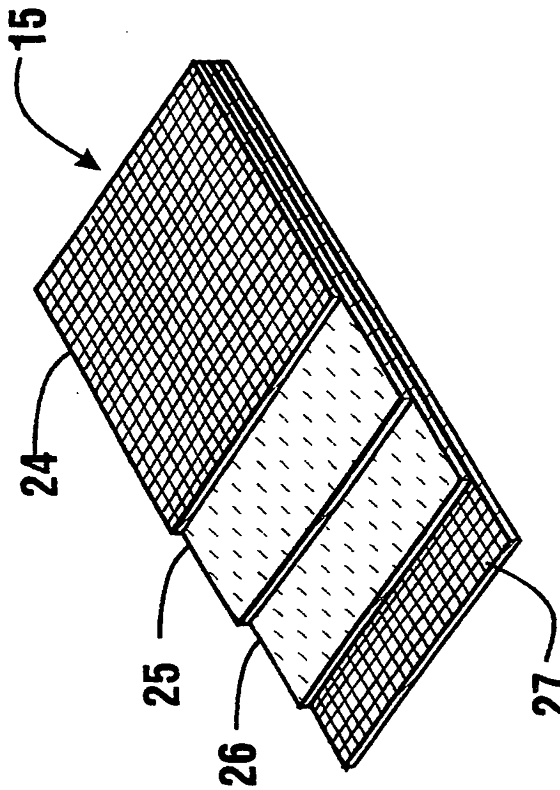


FIG. 1

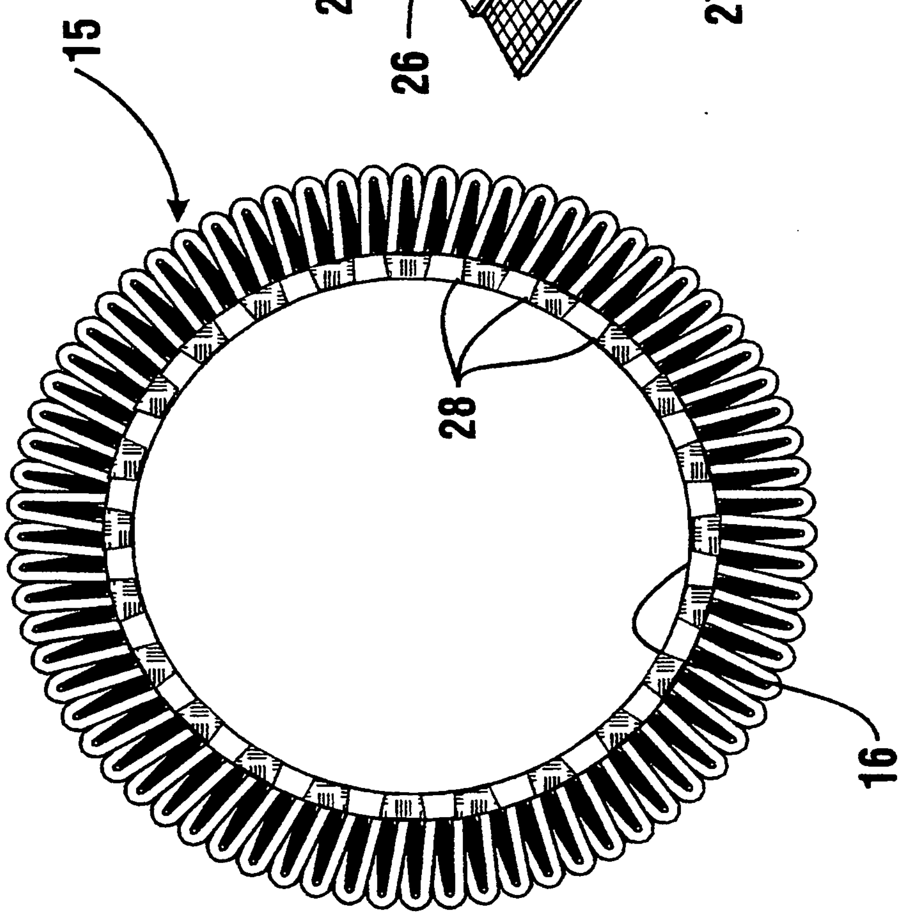


FIG. 2

Sheet 2/3

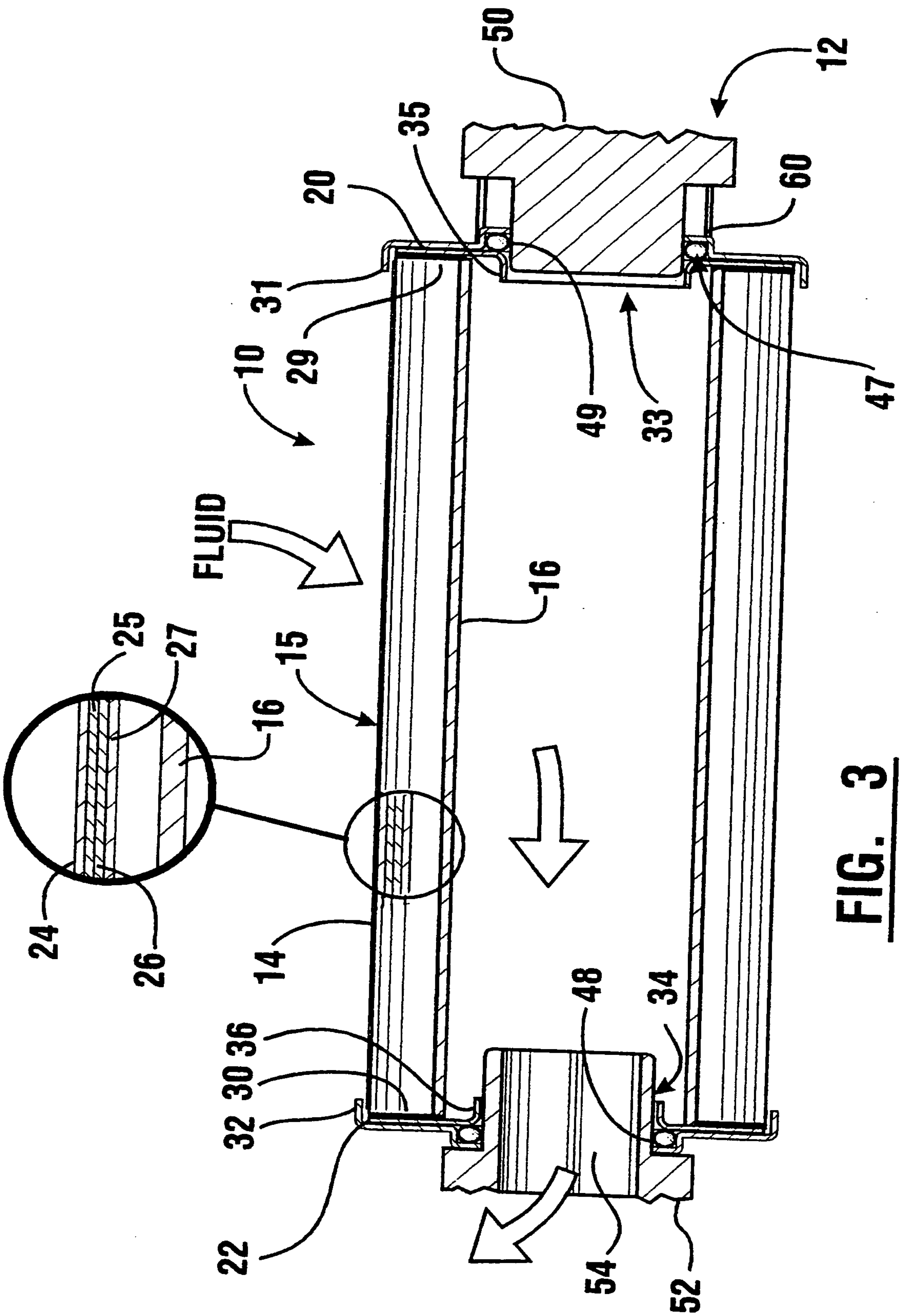


FIG. 3

Sheet 3/3

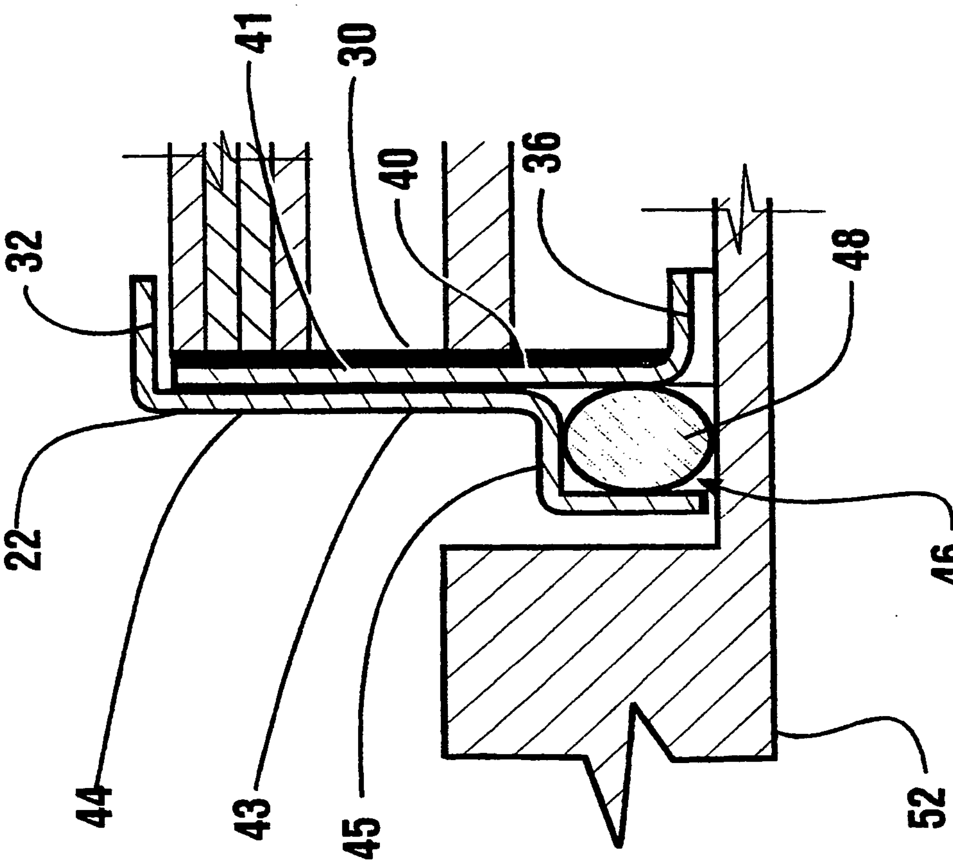


FIG. 4

INTERNATIONAL SEARCH REPORT

Int .tional Application No
PCT/US 96/09729

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D35/06 B01D46/42 B01D46/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,3 933 643 (COLVIN FLOYD E ET AL) 20 January 1976 cited in the application see the whole document ---	1-6,10, 11, 13-16, 18-20
A	DE,C,33 25 526 (PUROLATOR FILTER GMBH) 25 April 1985 see the whole document ---	1,3,5,6, 8-11, 14-16, 18-20
A	WO,A,87 01301 (EASTMAN KODAK CO) 12 March 1987 see claims 1-16; figures 2A,5A,9-13 ---	1,6-10, 12-16, 18-20

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
11 October 1996	31. 10. 96
Name and mailing address of the ISA	**Authorized officer**
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Cubas Alcaraz, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int ational Application No
PCT/US 96/09729

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 402 657 (KNECHT FILTERWERKE GMBH) 19 December 1990 see the whole document ---	1
A	US,A,4 999 108 (KOCH PAUL ET AL) 12 March 1991 cited in the application see the whole document ---	1-6,10, 11, 13-16, 18-20
A	WO,A,92 04097 (ALLIED SIGNAL INC) 19 March 1992 see claims 1-20; figure -----	1,17

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inu .tional Application No
PCT/US 96/09729

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3933643	20-01-76	CA-A- 1010380	17-05-77
		DE-A- 2244414	15-03-73
		GB-A- 1401816	30-07-75
DE-C-3325526	25-04-85	NONE	
WO-A-8701301	12-03-87	AU-A- 6229486	24-03-87
		EP-A- 0236425	16-09-87
EP-A-0402657	19-12-90	DE-C- 3918342	07-06-90
US-A-4999108	12-03-91	DE-A- 3818595	07-12-89
		DE-U- 8816817	30-08-90
WO-A-9204097	19-03-92	US-A- 5076920	31-12-91
		AU-B- 642616	21-10-93
		AU-A- 6916191	30-03-92
		CA-A- 2089647	01-03-92
		DE-D- 69016464	09-03-95
		DE-T- 69016464	05-10-95
		EP-A- 0545924	16-06-93
		ES-T- 2067917	01-04-95
		JP-T- 6500373	13-01-94
		US-A- 5164084	17-11-92
		US-A- 5164879	17-11-92